Bulletin No. 55

PEPPER

CULTIVATION IN INDIA

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Pepper cultivati.

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This is the 55th of a series of bulletins being issued by the Farm Information Unit, Directorate of Extension, Ministry of Food and Agriculture, on agricultural and animal husbandry subjects. These Bulletins are so written as to give an overall picture of the farming practices in vogue in the country, with suggestions on improvements based on research results.

For any further information, and especially on the recommendations suitable for his locality, the reader is advised to contact the local agricultural officer.

Editor : M. G. Kamath

Farm Bulletin *No. 55*

PEPPER

CULTIVATION IN INDIA

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CONTENTS

	Page
The Pepper In India	3— 9
The Pepper Plant	9—27
Cultivation of Pepper	27—69
Economics of Pepper Cultivation	70—72
Diseases and Pests of Pepper	73—78
Uses of Pepper	79—80

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THE PEPPER IN INDIA

THE pepper is one of the most ancient and historic crops of India. The region comprising the forests and ghats of Kerala and the Kanara region of Mysore, where the pepper vine grows wild on the rich, moist, humus soils of the submontane tracts, is the original home of pepper. Pepper has been in cultivation in India from ancient times, and has been mentioned as an important spice in Sanskrit literature.

Pepper was highly valued by the Romans and, for centuries, formed an article of trade between India and Europe. Payments of rent used to be made in pepper and, often, ransom demanded included pepper besides gold and silver. Pepper was the chief commodity of trade between south-west India and the Middle East, the Mediterranean and central European countries. It was with the pepper traders that the first Christian missionaries came to Kerala in the first century A.D.

Vasco de Gama's discovery of a sea route to India led to the Portuguese and other European maritime nations acquiring a monopoly of the spice trade till the 17th century. English travellers to Thailand in the 16th century have recorded that pepper was being grown in that country. It is also reported that the Portuguese and the Dutch introduced pepper vines into Java, Sumatra, Borneo, Sarawak, the Malayan peninsula, Thailand, the Philippines and later into the West Indies. However, the exact period when the pepper plant was introduced into Malaysia is not known. It is thought that Indian emigrants to Java introduced pepper into that country sometime between 100 B.C. and 600 A.D. Pepper trading between Java and China is known to have existed in 1,200 A.D., and Marco Polo in 1280 A.D. records the presence of pepper in Malaysia.

It were the Dutch who in the 17th and 18th centuries introduced the organized pepper cultivation on a plantation scale into Java and other parts of the East Indies.

India continued to be the centre of pepper cultivation till the early 19th century. Afterwards, its cultivation was extended to the Malayan archipelago. There it became thoroughly established, and roughly 96 per cent of the world's production of pepper was being produced in the region.

The Second World War and the Japanese occupation of Malaya, Java and other parts of the East Indies brought about a standstill in pepper production in those regions. The pendulum of pepper industry again swung in favour of India and there was an unprecedented boom in pepper prices.

Indonesia and the East Indies have now brought back their pepper production to the pre-war level. It is, therefore, imperative that India organizes her pepper industry on a sound and scientific basis in order to regain her supremacy in this valuable dollar-earning spice and to successfully compete with other pepper-producing countries.

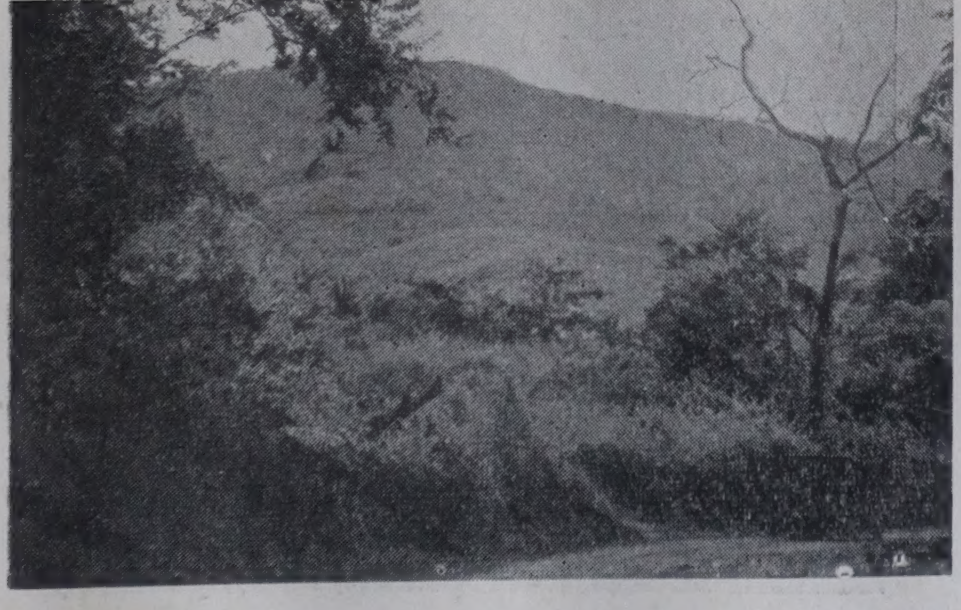
In India, Kerala is the most important pepper-producing

A homeyard pepper garden in Assam, with vines growing luxuriantly

There are many large-scale pepper plantations on the foot-hills of the Western Ghats in Mysore State

State, where pepper is cultivated on an organized plantation scale over fairly extensive areas. In North Kanara district of Mysore State, pepper is grown on a small scale mixed with arecanut, banana and cardamom. It is also grown on

A pepper plantation in the Western Ghats



a small scale in Assam and West Bengal and in scattered localities on the eastern slopes of the Western Ghats in the Tirunelveli, Madurai and Coimbatore disricts of Madras State.

The pepper-growing belt of the south-west coast of India comprises the following three naturally distinct regions.

(1) The Travancore and Cochin region.
(2) The Malabar and South Kanara region.
(3) The Coorg and North Kanara region.

Considering the varying climatic conditions, the nature of land and its elevation, the pepper-growing regions of the West Coast can be roughly classified as follows.

(i) The coastal area where pepper is grown in almost every compound or a plot of land in which a residential

A pepper plantation in West Coorg (Mysore)

building is situated. In such situations, pepper is seldom cultivated as a pure crop, and the number of vines in each compound may vary from a few to a 100.

The elevation of this area is usually not higher than 100 feet above sea level.

(ii) The low hills between the coastal area and the foot of the Western Ghats where pepper is cultivated rather extensively on the slopes and in the valleys.

The elevation of this area is not usually more than 500 feet above sea level.

(iii) The foot of the Western Ghats where the vine thrives best and produces good quality heavy pepper. These are the submontane areas with an elevation of 500 to 1,800 feet above sea level.

(iv) The Wyanaad Hills and the adjacent area of Coorg, which is an undulating plateau with elevations ranging from 2,000 to 3,500 feet above sea level, where the crop is extensively grown, interplanted with coffee and trained on shade trees.

(v) The Malnad areas or the hilly districts and the neighbouring uplands of Sirsi and Siddapur taluks of Mysore, where pepper is mostly cultivated as a subsidiary crop in the arecanut gardens; the arecanut tree forming the standard for the vine. These areas are on the eastern side of the Western Ghats having some features of Wyanaad and Coorg, but lower in elevation, generally not exceeding 2,500 feet above sea level, sloping off to the Mysore plateau. In some coffee estates in this region, pepper vines are trained on shade trees of coffee.

In West Bengal, pepper is grown on a very small scale in arecanut gardens, the arecanut trees serving as supports for the vines.

Pepper seems to have been introduced into Assam in 1904 for trials at a Government plantation at Wahjain on the southern slopes of the Khasi Hills, about seven miles from Cherrapunjee. At present, pepper is cultivated only in very small, isolated homestead gardens on the slopes of Khasi and Jaintia Hills and in upper Assam, but not on a commercial scale. These gardens are few and far between, and mostly in the interior. The total area under pepper in Assam is insignificant.

ACREAGE AND PRODUCTION

Pepper is essentially a homestead garden crop. In Kerala, almost every compound has a few pepper vines, their number varying considerably. These vines are mostly trained on mango, jack, arecanut, coconut or such other trees which can serve as a good support or standard. Almost every household in Kerala is self-sufficient in its needs of pepper, and sells the surplus in the market. It is the produce of the vines of these innumerable small compounds which contributes very largely to the production of pepper in India.

It is very difficult to obtain a reliable estimate of the acreage of this crop as the total area is made up chiefly of the innumerable homestead gardens distributed throughout the pepper-growing belt.

When the pepper industry became a Dutch monopoly in Indonesia and the East Indies in the later half of the 19th century, the industry in India was on the decline because the crop was never cultivated here on an organized and scientific basis. The temporary rise in the prices of pepper to about 700 rupees per candy in 1928 encouraged growers to cultivate the spice on a plantation scale, and pepper plantations were established in the eastern parts of Malabar, especially in north Malabar. It is these new plantations and the innumerable homestead gardens that are maintaining the

industry on the West Coast of India at present. The steady and increasing demand for pepper from the U.S.A. and the U.K. and the consequent phenomenal increase in its prices during the past decade has again encouraged the extension of pepper cultivation. New homestead gardens and plantations are, therefore, springing up everywhere on the West Coast. Even so, the Indian production of pepper has not kept pace with the increase in the world demand during the post-war period.

An estimate of the acreage and production of pepper in India in 1955-56 is given below:

State	Area in acres	Production in tons
Kerala	1,83,000	23,000
Madras	10,000	2,000
Mysore	19,000	2,000
Total	2,12,000	27,000

THE PEPPER PLANT

BLACK or white pepper of commerce is produced from the fruits of the pepper vine (*Piper nigrum*).

The pepper vine is a climber and requires a support or standard, which is usually a tree. It is a perennial plant, with a large, stout stem with many branches and a luxuriant, dark or pale green foliage. The vine can grow to considerable heights on large trees, even up to a 100 or 150 feet. The main stem and the branches of the vine hold on firmly to their supports with the aid of small finger-like aerial roots sprouting from the nodes of the stem and branches.

The leaves of pepper are either ovate or elliptical in shape, five to seven inches by two to five inches in size. In some forms, the two halves of the leaf blade are unequal.

Pepper is a shallow-rooted plant, with the root system within one to two feet of the soil-surface. It consists of not more than half a dozen main roots with a network of side roots.

On the West Coast, the vine flowers usually in June and July after the receipt of a few heavy South-west monsoon showers. Flowering may sometimes be initiated by heavy pre-monsoon showers in April or May. In certain localities on the eastern slopes of the Western Ghats and areas close to and on the eastern side of the Ghats, where the South-west monsoon rains are insignificant, pepper vines may flower with the North-east monsoon rains and produce some crop. This happens only in very favourable situations which satisfy the environmental requirements of pepper, at least to some extent.

The flowers of pepper are very small, white to pale yellow in colour and are borne on pendulous flower spikes two to six inches long. There may be anything up to 150 flowers on a spike. The spikes with open flowers have a catkin-like appearance.

The fruit is small, usually globose, but sometimes slightly elongated or oval, dark or pale green in colour turning to red or orange when ripe. It has a thin, soft pericarp surrounding the seed.

Pepper flowers are either bisexual (hermaphrodite) with the male and female parts in the same flower, or female with the female part only, or male with the male part only. Purely male vines bearing only male flowers occur very rarely

Another important feature of the bisexual cultivated varieties of pepper is the vast variability they exhibit with regard to the percentage of bisexual or productive flowers they produce on their spikes. The spikes produce not only bisexual flowers but also unisexual female and male flowers in varying proportions. The higher the percentage of bisexual flowers in a variety the greater is its productivity. Studies on the sexuality of cultivated pepper varieties have revealed that the percentage of bisexual flowers in a variety may vary from spike to spike, from vine to vine, from season to season, even from period to period within a season, and from region to region due to various factors both internal and external. No single, perfectly bisexual variety has yet been observed.

In the cultivated bisexual varieties of the South-west Coast of India, the percentage of bisexual flowers varies from ten to 98. This sort of flexibility in the sexuality of cultivated varieties seems to be an indication of the gradual evolution of bisexual varieties from unisexual ones by selection and vegetative propagation through the past thousands of years. A perfectly stable bisexual form may result from these changes in the not a too distant future. Most of the very high-yielding and popularly cultivated varieties produce from 70 to 98 per cent bisexual flowers, and the fluctuations of sexuality in such varieties due to internal and external causes is within limits. Under an intense shade, these bisexual varieties seem to have a tendency to produce more female flowers and less of bisexual flowers than where shade is regulated.

Pepper (*Piper nigrum* L) belongs to the pepper family *Piperaceae*, to which also belongs the betel vine (*Piper betel*), which closely resembles pepper vegetatively. *Piper longum* (*Thippili*) and *Piper cubeba* (*Valmulagu* or tailed pepper) which are of much value in indigenous medicine, also belong to this family. Many other members of this family grow wild in forests and resemble pepper vegetatively but

their fruits do not possess the pungency and the economic qualities of pepper.

CULTIVATED VARIETIES

There are a number of cultivated varieties of pepper peculiar to the different regions of the pepper belt. They are all known by local names. A considerable personal experience is required to distinguish between these varieties at sight, as the differences among them are not always very distinctly marked and the outstanding differences are more in their habits of growth than in their form. Familiarity with pepper varieties by a constant association is essential to acquire the ability to distinguish them from one another. A single variety, however, may often be called by different names in different localities.

Varieties of the Malabar and South Kanara region

The most common and outstanding varieties of pepper cultivated in the Malabar and South Kanara region are *Kalluvally, Balankotta, Karinkotta, Uthirankotta* and *Cheriakodi.*

Pepper varieties of Malabar
(1—3) *Kalluvally* **(4)** *Padappan* **(5)** *Karivilanchi*
with branched spikes

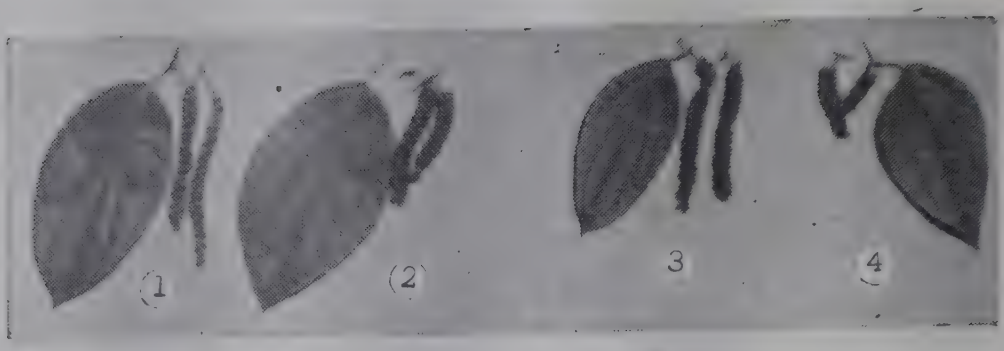
Kalluvally. This variety is predominantly bisexual and is distinguished by its bushy growth and dark green ovate leaves which are usually borne at an angle of 30° to 45° on more or less horizontal branches. The spikes are generally short and twisted with close-set, medium-sized, dark green berries. Its leaves are smaller than those of *Balankotta,* measuring on an average 17.11 centimetres x 9.62 centimetres. The name *Kalluvally* is derived from *Kullu* (stone), meaning hardy type with hard heavy berries. The berries of this variety are much heavier, bulk for bulk, and show less loss of water when dry than berries of other varieties.

Kalluvally shows the greatest variability in most of its features. Some forms of *Kalluvally* have leaves like those of *Balankotta,* whereas some have long and straight spikes like those of *Balankotta.* Four or five distinct forms of *Kalluvally* are observed, and even these forms show considerable variations within themselves with regard to sexuality, shape and size of leaf, spike and fruit characteristics.

Kalluvally is a very hardy variety and is capable of withstanding unfavourable weather conditions and exposed situations better than *Balankotta,* and is considered to be the most drought-resistant and wilt-resistant pepper variety of the Malabar region. This is also the most widely grown variety of pepper found in the Malabar region, and is grown extensively in the taluks of Kottayam, southern parts of Chirakkal, Kurumbranad and Wyanaad. It is grown either alone or mixed with *Balankotta, Uthirankotta, Cheriakodi* and *Karinkotta.*

Certain forms of *Kalluvally* may even beat the best forms of *Balankotta* in yield.

Balankotta. This variety is predominantly bisexual and can be distinguished by its larger pale green elliptical leaves borne drooping on partially drooping branches. Leaves of this variety seem to be the largest, measuring



Pepper varieties of Malabar
(1) *Balankotta* **(2)** *Kottavally* **(3 & 4)** *Kalluvally*

19.35 centimetres x 9.60 centimetres. The drooping of the leaves results in a tiled arrangement of the leaves hiding most of the spikes. The leaves are broadest in the middle. In some forms, the two halves of the blade are unequal. The spikes are long and straight and rather loosely and sparsely set with large, pale green berries. The berries are, however, lighter in weight, bulk for bulk, than those of *Kalluvally.*

This variety has much less variability than *Kalluvally*, though a few distinct forms are observed. One is a small-leaved form usually met with in Wyanaad, having shorter spikes and smaller berries but having other features of *Balankotta.*

Balankotta is a medium climber and a regular annual yielder, suitable for naturally shaded localities. This is rather extensively cultivated in the Chirakkal, Kottayam and Kurumbranad taluks of North Malabar and Wyanaad. In the Kurumbranad, Kottayam and southern part of Chirakkal taluk, this is usually grown mixed with the other Malabar varieties.

Kottavally. The well-known *Kottavally* or *Vally* variety of pepper which enjoys the greatest popularity among the South Kanara pepper growers, is another form of *Balankotta*, differing from the typical *Balankotta* in having dark green leaves and berries.

Kottavally is a regular yielder with much better setting of the berries. It is grown extensively on a plantation scale in the Hosdrug sub-taluk of the Kasaragod taluk and the adjacent northern parts of the Chirakkal taluk of North Malabar. *Kottavally* is also grown in South Wyanaad, mixed with *Kalluvally* and *Uthirankotta*. The variety is called *Kallubalankotta* in the Kottayam taluk of Malabar as the variety has some features of *Kalluvally*.

Cheriakody (*Cheria* - small). This variety comprises quite a few forms, distinguished by their smaller leaves and berries and smallness in all other respects. They are bisexual and fairly common in pepper gardens of Kottayam and Chirakkal taluks of North Malabar. Stray vines of *Cheriakody* are also seen in Wyanaad. *Cheriakody* is also called *Arikotta* in certain localities. The small berries may be dark or pale green. These forms produce heavy and high quality pepper and give very satisfactory yields in certain seasons but are not usually cultivated on a large scale.

A similar form is called *Arikottanadan* in the Trivandrum and Quilon districts of Kerala.

Karinkotta. This variety is distinguished from *Kalluvally* by its much larger, dark green leaves and larger berries. The size of the leaves, 19.38 centimetres x 7.97 centimetres, approaches that of *Balankotta* leaves. Its berries are larger and darker green in colour than those of *Kalluvally*, and are smooth and shining and very closely set on short curved spikes. One interesting feature of this variety is that the same vine produces leaves having the shape of those of *Kalluvally* as well as those of *Balankotta*.

This is a bisexual variety more commonly grown in the eastern parts of Kottayam taluk and grown mixed with other varieties in the southern parts of Chirakkal taluk and Wyanaad in Malabar. Sudden changes in weather conditions such as heavy, untimely rain or drought cause

shedding of spikes in this variety. Perhaps this is the reason why this productive variety is not very popular.

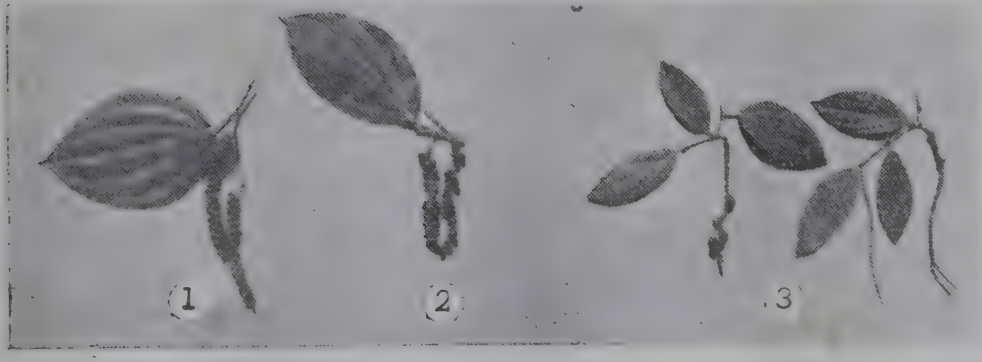
Uthirankotta (*Uthiran* shedder). This is a completely female variety, producing only female flowers. The features by which this variety can be distinguished from *Kalluvally* are its sparse branching and slightly lighter green, tough and leathery leaves with wavy margins borne at an angle of 50° to almost an horizontal position. *Uthirankotta* is the most sparsely branched type among the cultivated forms of pepper. The berries are larger than those of *Kalluvally*, light green, very sparsely set and borne on rather long and more or less straight spikes. Though this variety, because of its being completely female, is not favoured by growers, it is represented by a few vines in almost all pepper gardens in the Kottayam and Chirakkal taluks of North Malabar. *Uthirankotta* is also a poor yielder, susceptible to early spike shedding. *Uthirankotta* is known to produce good crops in certain years. Perhaps in these years, *Uthirankotta* vines get the advantage of pollen from other neighbouring bisexual varieties. It may be presumed that if grown alone, this variety will be a thorough failure just as the wild female ones. However, it is a hardy type producing profuse shoots at the base, and its cuttings rarely fail to strike roots.

There are bisexual forms of *Kalluvally* very closely resembling *Uthirankotta* vegetatively, indicating perhaps the close relationship between the two varieties.

Varieties of the Travancore-Cochin region

There are nearly a dozen cultivated varieties of pepper in this region, of which not more than ten are of much importance. The habits of growth and other features of the spikes and berries show that these varieties are of different origin from those of the Malabar region. A few of them resemble *Kalluvally* in leaf shape, but most of them look different in that they have more circular leaves than the cultivated Malabar varieties. The leaves of all these varieties are dark green.

(1) *Chumala* **(2)** *Munda* **(3)** *Velliara Munda* **(4)** *Karimunda*



(1) *Karimunda* **(2)** *Kothanadan* **(3) Two twigs of a male vine with male spikes. (Notice the formation of a few berries on one of the spikes)**

(1) *Karimunda* **(2)** *Chola* **(3)** *Narayakodi* **(4)** *Perumkodi* **(5)** *Kumbhakodi* **(6)** *Cheriakaniakadan*

Some produce long spikes, and others short. The berries are dark green, of medium size, except in one variety called *Chumala,* and are closely set on the spikes. The attractive features of these varieties are that they are very hardy, their cuttings srike roots easily and they climb standards without much external help. These varieties seem to be also relatively more resistant to the wilt disease.

The more common varieties cultivated in the Kottayam, Quilon and Trivandrum districts of the region are *Cheriakaniakadan, Valiakaniakadan, Karimunda, Narayakodi, Chola* and *Kothanadan.* Of these, *Karimunda* and *Narayakodi* are gaining popularity in the Central and North Travancore.

Karimunda. This is a very popular, high-yielding, predominantly bisexual variety extensively grown in the North and Central Travancore. The variety can be easily distinguished by its very dark green, oval-shaped leaves which often tend to be circular in shape. The tender leaves have a dark mauve colour. The spikes are of medium length, curved and closely set with dark green, medium-sized berries. The variety yields high quality, heavy pepper.

This variety is called *Karianadan* or *Karivally* in the Quilon district. *Karimunda* is a quick-growing and early-bearing variety but is short lived, seldom lasting for more than ten to 15 years. For this reason, it is considered most suitable for growing as an intercrop in coconut plantations during the pre-bearing period of the coconut trees.

There is also a variety called *Munda* which resembles *Karimunda,* except in the colour of the tender leaves. It is not so productive as *Karimunda.*

Narayakodi. This is another quick-growing and very early-bearing variety. It seldom has an economic life of more than 15 years and, as in the case of *Karimunda,* is very suitable for quick returns and can be grown as an

intercrop in coconut plantations. *Narayakodi* is also a very popular, high-yielding and predominantly bisexual variety, extensively grown in the Central Travancore and in the Kottayam district as well as in the northern parts of the Quilon district. The variety is distinguished by its smallish, ovate leaves with wavy margins on account of a twist or two in the leaf-blade. The leaf-blade is held in almost a horizontal position. The spikes are short and twisted with closely-set, medium-sized, dark green berries. All these peculiar features give the variety a very characteristic appearance The variety produces heavy pepper of high quality.

The variety is gaining much popularity in the region in recent times as it begins to yield in the second year, giving a very quick return to the grower.

Cheriakaniakadan. This is one of the most popular varieties of pepper grown in the Kottayam district and northern parts of the Quilon district. Although bisexual, the percentage of bisexual flowers in this variety is usually below 50, the rest of the flowers being mostly female. A tendency to become predominantly female is noticeable in this variety in certain seasons. However, the variety, because of its being cultivated mixed with other bisexual varieties, gives very

A vine of the variety *Cheriakaniakadan*, with pendulous tender spikes

high yields regularly and, hence, has gained great popularity with the pepper growers of the region. The spikes are of medium length, very often closely set with medium-sized, dark green berries. Heavy pepper of high quality is produced by this variety. *Cheriakaniakadan* can be identified by its smallish, drooping, elliptical leaves.

It is a very important fact that *Cheriakaniakadan* is comparatively resistant to wilt.

There is also a variety called *Valiakaniakadan* which has much larger leaves than those of *Cheriakaniakadan* but resembling the latter in most other respects. This is not, however, so heavy a yielder as the former and, therefore, is not so popular.

Veluthanamban. This is a bisexual variety grown in the Thodupuzha area of Kottayam district. It is easily disinguished by the whitish colour of its tender leaves, which is a rare phenomenon. The leaves are large, dark green and elliptical in shape. The spikes are of medium length closely set with medium-sized, dark green berries. It is a fairly productive variety and is grown mixed with other varieties in the Thodupuzha area.

Kuthiravaly. This is another variety found grown here and there mixed with other varieties throughout the pepper-growing areas of Travancore. The most distinguishing feature of this variety is its rather long spike assuming the shape of a horse-tail with a bend at the stalk-end. The berries are closely set on the spike and are large and elliptical in shape. In certain localities, *Kuthiravaly* has shorter spikes and oval leaves.

Although a bisexual variety, it gives yields only in alternate years. The percentage of bisexual flowers, though high in some localities, tends to be low in others.

Chola. This is a popular and productive bisexual variety grown in the western parts of Central Travancore, especially in the south-western parts of Kottayam district and the north-western parts of Quilon district. The most

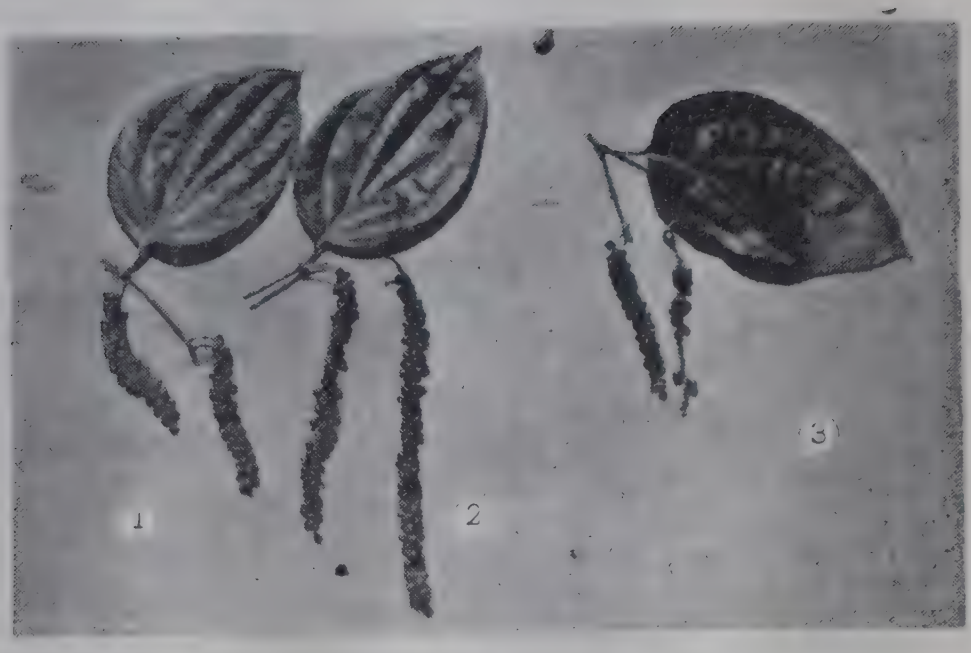
Pepper varieties of North Travancore
(1) *Perumkodi* **(2)** *Narayakodi* **(3)** *Kuthiravaly*
(4) *Karimunda* **(5)** *Veluthanambam*

distinguishing features of this variey are the medium-sized, drooping elliptical leaves and curved spikes of medium length. The spikes are closely set with medium-sized, dark green berries.

Kumbhakodi. This variety is grown in the north-eastern parts of the Quilon district mixed with other varieties. It is a predominantly bisexual and fairly productive variety with large, elliptical leaves and rather long and straight spikes usually closely set with medium-sized, dark green berries.

Karivilanchy. This is another variety found in Central Travancore mixed with other varieties. It is completely female like the *Uthirankotta* of Malabar. As it is grown mixed with other bisexual varieties which flower at the same time, *Karivilanchy* usually gives good crops and produces pepper of good quality. The leaves are ovate and medium sized and the spikes fairly closely set with medium-sized, dark green berries.

Chumala. This variety is peculiar to Ranni, Konni and Palhlanamhitta in the north-eastern parts of Quilon district. Very large, broad, ovate and pale green leaves with a drooping tendency and long straight spikes with large, pale green berries which turn orange when ripe, are the distin-



Pepper varieties of South Travancore
(1) *Kuthiravaly* (2) *Kothanadan* (3) *Padappan*

guishing features of this variety. In all these respects, except in the shape of the leaf, this variety has a striking resemblance to the *Balankotta* of Malabar. The variety is predominantly bisexual, has good fruit setting and, therefore, is fairly popular in the area. Like the *Balankotta* of Malabar, this vine prefers shaded and protected situations.

Kothanadan. This is the most popular variety of pepper grown in the Kottarakara area of Quilon district, and in the Nedumangad area of Trivandrum district. Being very predominantly bisexual with long straight spikes closely set with medium-sized, dark green berries, the variety is very productive and, hence, very popular. The leaves are medium sized and ovate.

Perumkodi. Stray vines of this variety can be observed throughout the pepper-growing regions of Kerala. The name *Perumkodi* means a large vine. The vine grows to great heights on tall trees and lives for long periods even up to a hundred or more years, giving satisfactory yields. The percentage of bisexual flowers in a spike of this variety is rarely more than 20, the rest of the flowers being mainly female.

The productivity of this variety, therefore, depends also on the availability of pollen from neighbouring vines. Most vines of this variety give yields only in alternate years.

The variety has large, oval leaves and fairly long, straight spikes closely set with dark green, medium-sized berries.

Perumkodi is evidently a bisexual form which has not advanced sufficiently in the scale of evolution of bisexual varieties of pepper. Although not very extensively cultivated, the variety is often met with growing on large mango, jack and such other trees in homestead gardens. The variety is also called *Padappan* in certain localities on account of its rapid growth.

There is very little pepper cultivation in the Cochin region, limited mainly to Angamali, Chalakudi, Ollur, Trichur and Pattikad, and that too only in small homestead gardens. The varieties grown here must have been imported from the Travancore region.

Varieties of the North Kanara and Mysore region

There are six or seven varieties of pepper grown in North Kanara and the adjoining area in the Mysore State. They are locally known as *Malligasera, Karemalligasera, Doddagya, Motakara, Morata, Arisina-morata, Tattisara* and *Vakkalgooja.* Of these the first four seem to be productive and high-yielding varieties. These varieties look different from the pepper varieties of the Malabar and the Travancore region and must have originated from the wild pepper vines of the forests of North Kanara and the adjacent areas.

Malligasera, Karemalligasera, Doddagya and *Motakara* are predominantly bisexual varieties which are very popular in this region. They all have ovate, medium-sized leaves except *Doddagya* which has a slightly larger leaf. *Karemalligasera* has long spikes which are straight and closely set with medium-sized, dark green berries, and is the most productive

Pepper varieties of North Kanara

(1) *Malligasera* **(2)** *Karemalligasera* **(3)** *Doddagya* **(4)** *Motakara*

of the four varieties. *Malligasera* has spikes of medium length but fruit setting is rather poor. *Doddagya* has also spikes of medium length which are closely set with berries. *Motakara* has a slightly narrower leaf and short spikes which are closely set with berries of dark green colour. The main difference among these varieties is in the nature of their spikes.

The description of the various pepper varieties show that the differences among them are rather subtle and, as stated previously, a constant association with them is essential to acquire the ability to distinguish them. A change of environment may also bring about some changes in the characteristics of the varieties. Certain early-bearing varieties may become late bearers when planted in other localities with different environment. Their sexuality with regard to the

percentage of bisexual flowers may also be affected by a change of environment. Trials of different varieties in different regions may reveal these tendencies. During the last decade, people from Travancore-Cochin who have settled down in Malabar and South Kanara have introduced several pepper varieties of the Travancore-Cochin region in these areas. These introduced varieties are bound to become an important element of the pepper crop of Malabar and South Kanara in the near future.

CULTIVATION OF PEPPER

THE pepper thrives best in places where the annual rainfall is well over 80 inches and never less than 50 to 60 inches It requires a warm and humid atmosphere. Pepper vines can withstand wide fluctuations of temperature as the maximum and minimum temperatures in the pepper-growing tract are 104°F and 50°F, respectively.

In Gangawarpatti, a village at the foot of the Kodaikanal Hills, east of the Western Ghats, which receives a rainfall of only about 25 inches annually, a cultivator has successfully grown pepper under irrigation, along the margin of his vineyard. The pepper vines which were planted in 1950 started bearing from the fourth year. The growth and bearing of these vines, however, do not compare favourably with those of the vines of the West Coast. It must be mentioned that normally pepper is grown as a rainfed crop. The success achieved by the cultivator in growing pepper under irrigation in a locality with only 25 inches of rainfall indicates the possibility of producing pepper in house compounds in low rainfall regions to meet the domestic needs, though not as a commercial proposition.

On the eastern slopes of the Nilgiris, pepper is grown fairly successfully on a small scale as an intercrop

Pepper vines interplanted with coconut at Thodupuzha in North Travancore. Notice a vine growing on a wild date-palm

in some of the tea and coffee plantations. Here the vines are trained on the shade trees. These localities have an elevation of less than 4,000 feet and an average annual rainfall of only about 50 inches, with very little rain during the South-west monsoon. The growth and yield of these vines are satisfactory and compare favourably with those of the pepper vines on the West Coast. On these eastern slopes of the Nilgiris, two crops of pepper are obtained, the main crop harvested in June and the secondary one in February-March. The former results from the North-east monsoon rains and the latter from the South-west monsoon rains.

Certain enterprising planters in the Anamallais, Courtallam Hills and Singampatti Hills along the eastern slopes of the Western Ghats, and on the Eastern Ghats have planted pepper during the past few years and trained it on shade trees in tea, coffee and cardamom plantations. The growth

of these vines is satisfactory. It should be mentioned in this connection that there is an abundant growth of wild pepper in the forests of these regions, and this indicates that in such hill regions with a low rainfall, pepper can be cultivated with some success.

Unlike in other crop plants, the chief agency for the pollination of pepper flowers is rain-water. It is a well-known fact that satisfacory yields of pepper cannot be obtained unless there are frequent showers of rain during the blossoming period of the pepper vines; in areas where these conditions are not obtainable, production of pepper on any considerable scale is not feasible. Long spells of dry weather which may cause the soil to dry up are also harmful to the pepper vines which may die simply due to a severe drought or may be rendered susceptible to wilt and other diseases.

SOIL

The pepper thrives best on a virgin land for the simple reason that it needs a soil rich in humus and plant nutrients. And that is why it does not grow well on a land which has been previously intensively cultivated or on which pepper has been grown in the previous years. A well-drained, red lateritic virgin soil, rich in humus, is very suitable for pepper. This is the kind of soil commonly met with on the West Coast. Experienced pepper growers are of the view that land having granite rock underneath, preferably with granite boulders, is still better. How the presence of granite helps the growth of pepper is not clear. Perhaps on hill slopes with a granite bed there may be seepage of water along the surface of the rock, which not only drains away the excess moisture of the soil during the rainy season but also keeps the soil sufficiently moist during the dry season.

It is also a possibility that granite contains several trace elements and other plant nutrients which may be available to the pepper vines. Pepper needs a well-drained soil, but the soil should not dry up completely during the dry months.

During recent years due to the persistent failure of the North-east monsoon in October and November, a large number of vines have dried up throughout the West Coast due to severe droughts as well as due to the resultant incidence of wilt and other diseases. The effect of the drought was observed to be not so harmful in certain situations where the vines were not exposed much and the soil did not dry up so easily. There is a common belief that a sloping land is better for pepper than a flat land, but pepper is found to grow equally well on a flat land provided the soil is well drained. Alluvial soils which are not subject to floods and water stagnation are also excellent for growing pepper. It also grows very well even for a hundred years or more in the homestead gardens in the plains, where a continual replenishment of the soil with humus and other plant nutrients takes place naturally.

In certain parts of Kerala, pepper is very successfully grown on raised bunds on the edges of water-logged paddy fields. The top surface of the bunds on which the pepper

A homestead pepper garden in Kottayam, Central Travancore. The vines are trained on coconut trees and teakwood posts

vines stand is only about three to four feet above the level of the stagnant water in the ditches between the bunds. In such situations, the soil-moisture-requirements of the vines seem to be very nearly optimum, and the vines never suffer from drought at any time.

When pepper is grown on slopy land, a slope facing south should be avoided, as in the hottest part of the year it is this side that suffers most from the severe southern sun. Therefore, while selecting a site for raising a pepper garden, it should be borne in mind that a very well-drained soil rich in humus-content and other plant nutrients is suitable for pepper cultivation provided the climatic, topographical and other conditions of the terrain, suitable for the normal development of the pepper vine, are satisfied.

PROPAGATION

The pepper vine can be propagated either vegetatively or by seeds. The usual practice adopted throughout the pepper-growing districts is to propagate the vine vegetatively from cuttings. Raising a crop of pepper from seed is not only a laborious, slow and uncertain method, but also the seedlings take a much longer period for bearing, and the seedlings are likely to differ considerably in growth, productivity and other features from the parent vine. However, raising of seedlings is an unavoidable process in work connected with hybridization and breeding of the crop. For pepper growers, propagation through cuttings is the most suitable method.

The methods of vegetative propagation practised in the pepper-growing tracts of the West Coast of India vary to some extent. Some of them are described below.

Runner cuttings. Runners or the vegetative shoots that grow from the lowermost two feet of the vine are most suitable for propagation. The healthiest among these shoots are selected and kept coiled in a fork of two or three sticks

Runner shoots of pepper vines twisted on forked sticks

planted near the vine in such a way that the shoots do not come in contact with the soil. If these shoots are allowed to come in contact with the soil, roots are formed at the nodes and the runners become useless. These runner shoots are separated from the parent vine at the time of planting, cut into lengths of four or five nodes and planted near the standards. Usually four such cuttings are planted to each standard tree. This method is adopted by the growers in most of the pepper tracts. If the runner cuttings are planted in the rainy season immediately after they are removed from the parent vines, anything from a 20 to 50 per cent success can be obtained.

Terminal shoot cuttings. In certain localities in Kerala and North Kanara, cuttings from the terminal shoots of the

fruiting branches at the top of the vines are used for planting. Plants raised from such cuttings begin to bear even in the second year and produce a satisfactory crop from the fourth year onwards, while plants raised from runner cuttings give satisfactory yields only from the sixth or the seventh year. Such early bearing of plants thus raised reduces the life of the vines by three to four years without, however, affecting their total yield in any way. The life of vines in these localities is about 15 years. This method of propagation seems to be advantageous to those growers who plant pepper as an intercrop in coconut or other plantations with a view to getting a quick return. The removal of fruiting branches from the top of the vines is highly detrimental to the productivity of the mother vines, and, therefore, such cuttings should be sparingly used.

In Indonesia, Thailand and Malaya, it is reported that propagation by terminal shoot cuttings is invariably resorted to and vines for the production of such terminal shoot cuttings are raised in special nurseries.

Terminal shoot cuttings shuld be about two feet in length with five to seven nodes, the internodes being three to four inches in length. Before a cutting is taken from the vine, the terminal bud of this selected shoot should be broken off and the leaves and small branches between the third and the seventh nodes from the apex of the shoot stripped. After about ten days, the regeneration of the terminal bud is evident. The shoot should then be cut below the seventh node and the cutting removed, care being taken not to damage the finger-like aerial roots which sprout from each node and which hold firmly to the support. Cuttings can be planted straight away near their support trees. The stem of the cutting should be planted obliquely, not deeper than four to six inches, with three to four nodes below the ground level. Anything up to a 90 per cent success in the field can be obtained with these cuttings. If, however, these cuttings are rooted

in a nursery before planting out, a cent per cent success can be obtained.

Layers. The method of raising layers of pepper vine in baskets for propagation, is adopted by growers in the Malabar and South Kanara region. Shallow bamboo baskets, two to three inches in depth and six to eight inches in width, are filled with good surface-soil, and selected runners of good vines layered in them. Within four to six weeks, when roots have formed, the layers are carefully separated from the parent plant and planted in prepared pits near the base of the standards. Sometimes coconut husk is used in place of baskets. Layers can be raised in bamboo tubes also. Almost a cent per cent success can be achieved by this method, but layering can be undertaken only to fill up gaps and cannot be practised on a large scale. Transport of layers is an important consideration and, hence, layering is best done in the same garden in which planting is to be done.

Trials on layering of pepper vines conducted at the Pepper Research Station, Panniyur, North Malabar, Kerala, have shown that layering is more or less successful throughout the year provided the layers are watered during the dry months. In layering, nodes nearer to the tip of the runner shoots strike roots quicker and better than the nodes furher away. A single runner shoot could be layered at intervals of five nodes and four or five layers could be obtained. This is of particular advantage to small growers who have only a very limited supply of runner shoots in their holdings.

In gardens where vines are trained on arecanut trees, layers trained on stakes are commonly used. Stakes of arecanut stems about six feet by four inches are driven into the soil about two to two and a half feet away from the parent vine, and the vegetative runners from the base of the vine trained along the ground and on the stakes. Roots are formed at the nodes which touch the ground and which are lightly

covered by soil. As soon as the roots are sufficiently developed, the layers are carefully severed from the parent plant and planted near the base of an arecanut tree. Casualities among such layers are usually low. This method is practised in the North Kanara and Mysore region.

Rooted cuttings. Owners of small gardens in Coorg, often raise rooted cuttings in small nurseries. Cuttings from runner shoots of selected vines are taken at the end of October and planted in a nursery when the soil is still moist with the last rains of the North-east monsoon. With proper watering and provision of suitable shade, the cuttings strike roots early. During the next rainy season (July), they are removed with a ball of earth and planted in the field. A large number of small nurseries can be raised in a garden so that there will be enough planting material available. This system can be of special advantage if the planting material is selected in October or November, when the vines are in full bearing so that cuttings for the nursery can be taken from selected vines.

As the plant raised from rooted cuttings or layerings get one year's growth in the nursery, they come to flower earlier than the ordinary cuttings. This method can be adopted with advantage on a large scale in all pepper-growing tracts

Experiments on rooting of cuttings conducted on a large scale at the Pepper Research Station, Panniyur, showed that it is best to raise rooted cuttings in containers. The most suitable containers are found to be special bamboo baskets, nine inches to about a foot in length and four to five inches in diameter. A couple of pepper cuttings with four nodes each are placed in each basket. The basket is then filled with ordinary gravelly surface-soil so that the lower two nodes of the cuttings are covered by it. The soil is pressed down properly and the baskets kept under a thatched roof or a *pandal*, preferably the former, and regularly watered until the cuttings strike roots and are ready for planting.

In order to determine the most suitable medium for rooting pepper cuttings, trials were conducted with four different media, namely, ordinary gravelly surface-soil, potting mixture (loamy soil with high humus-content, powdered cattle manure and sand in the ratio 2:2:1), potting mixture and paddy husk in the ratio 2:1, and plain coarse river sand. Ordinary gravelly surface-soil and potting mixture were found to give about the same percentage of success, the former being slightly better.

Trials have also shown that the season from January to May is better than the rest of the year for raising rooted cuttings for planting. The bamboo baskets are not very durable; usually they rot by the time the cuttings are ready for planting. Planting may be done with the basket without disturbing the roots. For purposes of transport and for distribution to growers, ten or 15 of the small baskets of rooted cuttings may be packed into a larger basket without disturbing the roots of the young plants. If planted out in the right season with favourable weather conditions, a 80 to 90 per cent success can be obtained with these pre-rooted cuttings. At present, this is the best method for large scale plantings of pepper. Some of the more progressive growers on the West Coast have now realised this and have started raising rooted cuttings in containers, as this reduces the percentage of failures to a very great extent.

Grafting. Research conducted recently at the Pepper Research Station, Panniyur, has revealed that pepper vines could be grafted by inarching as well as by side-grafting Cultivated and wild varieties of pepper could be grafted on to each other. Rooted cuttings and growing shoots of old vines of cultivated varieties could be easily inarched to each other. The union between the stock and the scion was found to be complete and the grafts ready within 75 days of inarching. Although inarching of pepper vines could be successful throughout the year, the period from October to January was found to be the most suitable for the operation.

Single node cuttings can be successfully side-grafted. The union of the graft is found to be rapid, the growth starting within 15 days and proceeding vigorously. Side-grafting is an easy process and can be carried out successfully by anybody with a few days training. This is a rapid method of multiplication of pepper plants and can be adopted by growers.

A grafted (side-graft) pepper vine plant

The usefulness of propagating pepper vines by grafting is multifold.

The success of grafting trials have indicated the possibilities of exploiting the root-stock resistance for the prevention of wilt disease. The attack of wilt comes through roots. The root system of the wild as well as some of the cultivated varieties like *Uthirankotta, Kalluvally* and *Cheriakaniakadan* is completely or partially resistant to the attack of wilt.

TWO GRAFTED PLANTS

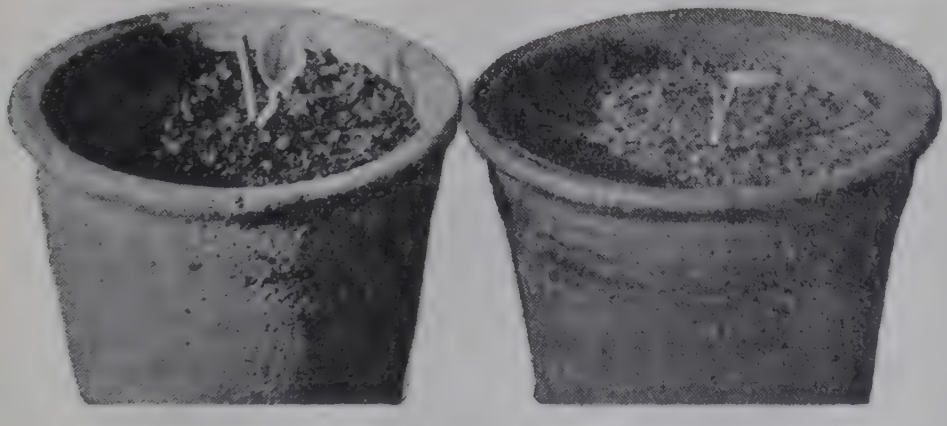
(Left) Betelvine on *Piper attenuatum* (approach graft); (right) *Kalluvally* on *Uthirankotta* (side-graft)

The productive susceptible varieties could be grafted on to root-stocks of these resistant varieties, thus evading the incidence of the dreaded wilt disease.

Uthirankotta and other varieties, which are pure female types, can be made more productive by topworking or grafting a few shoots in the top portion of such vines, with shoots having lateral branches (flowering shoots) of productive bisexual varieties, so that the necessary pollen for fertilization of the flowers of the female varieties could be made available. There is a considerable population of such female vines in house compounds and the mixed plantations in Kerala. If topworking proves a success, these poor yielders can all be made productive.

It is also an exceedingly useful and interesting finding that pepper vines could be grafted on to betel vine (*Piper betel*) and betel vines on to pepper. In this case also, single node cuttings could be used. This finding that pepper can be side-grafted and inarched on betel vine is of great importance, as by using betel vine as a root-stock for pepper, it would be possible to grow pepper even in sites which are liable to be waterlogged to some extent as the roots of betel vine generally withstand an excessive soil moisture much better than pepper.

Single node cuttings. In recent years, energetic attempts have been made in the United States to introduce pepper vine and grow it as a commercial crop in Puerto Rico with a small number of pepper cuttings imported from India. A worker raised pepper plants by inserting single node cuttings into the soil. These cuttings developed roots in seven to 14 days. Similar success with single node cuttings of pepper was obtained in Ceylon and in the West Indies.



Single node cuttings of pepper seen sprouting

At the Pepper Research Station, Panniyur, trials of raising pepper plants with single node cuttings are being conducted. Single node cuttings with about two inches of stem above and below the node with leaves and without leaves were inserted in nursery beds under shade. Some of these cuttings were found to develop shoots and roots within 18 days. Single node cuttings without the leaf attached,

were found to start growing earlier than cuttings with the leaf attached, but the later type of cuttings gave a greater percentage of survival than the former type at the end of one month.

These trials have indicated the possibility of propagating pepper on a large scale. The advantage of a single node cutting is that about five times more plants can be raised by this method from the same plant material than by the ordinary method. Rapid multiplication of high-yielding and quality pepper vines can be undertaken by this method.

Now that the success of grafting trials have indicated the possibilities of exploiting the root-stock resistance to the wilt disease and the tolerance of betel vine root-stock for an excessive soil moisture, the relative growth, vigour and productivity of a particular variety of pepper on different varieties of root-stock like that of wild pepper, cultivated pepper and betel vine, have to be determined by actual experimentation. Such experiments are under way at the Pepper Research Station, Panniyur.

Propagation by seed. Raising seedlings for propagating pepper is not at all popular as it is laborious and slow, and the results are uncertain. The seedlings of pepper may not be true to the mother plant. They take nearly seven to eight years for bearing. However, it is generally believed that vines raised from seedlings, though late in bearing, live several times longer than vines raised from cuttings, and give heavy crops later in life after they have extensively spread on mango, jack or other trees in household gardens. It is reported that in the past, some people used to raise pepper seedlings for growing in household gardens and that some of the old pepper vines now found growing on huge mango and jack trees may have been raised from seedlings. A fairly large number of pepper seedlings sprouting on the ground can be observed in old pepper gardens towards the latter half and end of the South-west monsoon. In work connected with hybridization and breeding, hybrid progenies have to be raised through seed.

SOME HYBRID SEEDLINGS OF PEPPER

Careful experiments on germinating pepper seeds conducted at the Pepper Research Station, Panniyur, showed that anything from 90 to 100 per cent of seeds germinated within two months of sowing under certain conditions. These tests showed that (a) the seeds should be sown in potting mixture or fine porous, rich surface-soil with a high humus-content in a germinating box or a seed-bed under thatched roof, (b) the seeds should be sown shallow, not more than $\frac{1}{8}$ inch below the soil-surface, (c) the stigmatic end of the seed should face upward in the seed-bed to get the best germination, (d) the germination of seeds with the seed coat is generally quicker than that those without the seed coat and (e) sowing the seeds with seed coat after drying them for three days in shade gives the best results.

PLANTING

In the Malabar and South Kanara region, usually virgin jungle land is selected for planting a pure crop of pepper, especially on a plantation scale. Land which has been previously under hill paddy (*Punam*) or other cultivation and left uncultivated and overgrown with scrub jungle for at least six years after the previous crop, can also be utilized for pepper growing.

The land is cleared of all trees, undergrowth and stumps of dead trees. Pits $1\frac{1}{2}$ feet x $1\frac{1}{2}$ feet x $1\frac{1}{2}$ feet are dug eight to 15 feet apart in rows, according to the fertility of the land. The higher the fertility the wider is the spacing adopted. In the interior parts of Malabar and South Kanara, 1,000 vines are planted in three acres with roughly a 12 feet x 12 feet spacing. The pits are then filled with loose jungle earth and leaf-mould. When the first heavy rains are received in May or June, *murikku* (*Erythrina indica*) standards raised from seed are cut and planted. Within a fortnight, these standards strike roots and get established.

After the South-west monsoon has set in, pepper cuttings are planted in the pits, at the base of the standards, a foot away. These pits are one foot long, six inches broad and

about a foot deep. Usually four to five cuttings, two to two and a half feet long with four or five nodes on each, are planted to each standard. The pits are then filled with surface earth. If pre-rooted cuttings are planted, two such cuttings may be planted to each standard.

The southern aspect is always avoided as the afternoon sun in the summer months, may kill the plant outright or cause a severe sunburn. At least two nodes of each cutting should be buried in the soil. The soil around the planted cuttings is pressed hard and a slope is given to prevent stagnation of rain-water. The portions of the cuttings above the ground are pressed close to the standard. Mulch is provided by putting grass or dry leaves around the planted cuttings. The growing cuttings are attended to periodically, and are tied on to the standards as they grow. In the first year, they grow up to a height of about five feet.

From time immemorial, the practice on the West Coast is to plant pepper at a particular period called *Thiruvathira Nhattuvela,* which usually falls in July-August during the South-west monsoon, and is considered the most favourable for the young pepper plant to strike roots. Some growers are, however, of the view that pepper cuttings could be planted with advantage in May, immediately after the receipt of a few heavy summer showers, so that the young vines get a good start and grow vigorously with the onset of the monson. But it is risky to plant the vines so early, because if there is no rain for a long time after planting, casualities may be high and the vines may be killed by the hot sun.

The percentage of success usually obtained in planting unrooted fresh cuttings directly into the field, especially on a large scale, is not more than 30 per cent. It may be even much less. As such, the method of raising rooted cuttings in containers described above may be adopted with advantage.

In the Travancore region, the practice of raising a pure crop of pepper is different from that in the Malabar and South Kanara region. The undergrowth is first cleared and some of the standing trees are utilized as standards.

Thinning of the standing trees is done to provide some sort of spacing. Naturally there is a considerable variation in the number of vines planted to an acre, and trees of various sizes, ages and varieties are found in typical pepper plantations of Travancore. The number of cuttings planted under each standard varies according to the size of the standard. Planting of pepper cuttings is done in semi-circular pits dug on the northern and eastern sides of the standard trees. Three to 15 fresh cuttings are planted to a standard, depending on the girth of the trees, the ends of the cuttings being tied to the standards.

Casualities may occur among the vines during the first two to three years. These have to be replaced at the right season.

STANDARDS

The pepper vine being a climber needs a support or a standard to climb on. The standard is usually a tree. The standards are provided prior to the planting of the vines. They not only provide support to the vines but also give them some shade. Mostly, only living trees are used as standards for pepper vines in India, whereas dead wood posts are generally used as standards in Malaya and Indonesia.

Pepper climbs on all rough barked trees and thrives well on common trees like mango, jack, *thekkan karayan* or *kilinjil* (*Garuga pinnata*), *murikku* (*Erythrina indica*), *ambayan* or hogplum (*Spondias mangifera*), *payyani* or *azhanthal* (*Oroxylon indicum*), tamarind, teak, silver oak (*Grevillea*), *Glyricidia maculata*, coconut, arecanut, bastard sago palm, palmyra palm, wild date and such other trees which are mostly found in household gardens.

During the last 50 years, pepper which was largely a household garden crop in India, has emerged as a plantation crop, and fairly large-sized plantations of pepper are raised in the submontane eastern parts of North Malabar and the Hosdrug taluk of South Kanara. Large scale planting necessitated adoption of a uniform spacing of the vines. The growth of the standards and the vines had also to be

A good pepper garden, with vines trained on teakwood posts and coconut trees

regulated and standardized. These processes called for the use of a standard tree which could be subjected to such treatments. *Murikku* was found to be the most suitable for these treatments in a large plantation. In the pepper plantations of North Malabar and South Kanara, *murikku* is still the best standard so far known. It is propagated easily, and is a quick-growing tree. It grows straight without many side branches and has a rough bark which secretes a sticky fluid which enables the climbing roots of pepper to get a firm hold. It can stand an annual lopping without much deteriorative effect. *Murikku* being a leguminous plant, enriches the nitrogen content of the soil.

Preliminary comparative tests conducted on the growth and development of pepper vines on *murikku* and other quick-growing trees which are propagated through cuttings such as *Garuga pinnata* and *Spondias mangifera* showed that the development and yield of pepper on *murikku* was definitely superior. The tree has, however, the disadvantages of having a shorter life and the habit of shedding leaves during the hot months when pepper vines need some shade.

Erythrina indica (*murikku*). The common method of raising *murikku* standrads in Malabar is by sowing the seeds of

An avenue of pepper vines grown on *Glyricidia maculata*

Pepper vines grown on jungle trees

Pepper vines are grown on *murikku* standards in this garden in West Coorg

the tree along with hill paddy. After the harvest of the paddy crop, *murikku* seedlings are allowed to grow undisturbed. When the plants grow from five to seven feet in height and six to eight inches in girth (this requires two to three years), they are cut close to the ground and stacked horizontally in the shade of trees for two or three weeks. These cuttings are then removed and kept in a slanting position at an angle of about 60° for about a month when new shoots and roots are produced on them. They are then planted out in the field at the required spacing. When the standards establish themselves in about three weeks, pepper cuttings are planted.

In the Travancore-Cochin region also, *murikku* standards are commonly used in household garden crops of pepper, but an important difference here is that only cuttings or branches of grown-up *murikku* trees are planted as standards in this region. The life of the standards raised from such cuttings is short, rarely more than 12 to 15 years.

The variety of *E. indica* of the Malabar and South Kanara region is entirely different from that of the

Travancore-Cochin region. The former has small, cream-coloured seeds, resembling those of cowpea while the latter has large seeds nearly an inch long and of a reddish brown colour. The flowers of the latter are also brighter red in colour than those of the former. The Malabar and South Kanara variety of this tree is in all respects more suitable as a standard for pepper vine than the Travancore-Cochin variety. The Travancore-Cochin variety does not seem to be so amenable to the treatments to which the tree is put in a pepper plantation as is the Malabar-South Kanara variety, whose average life in the pepper plantations of this region is 25 years.

In the foothills of the Western Ghats and in Wyanaad at elevations ranging from 1,000 to 3,500 feet, *E. indica* standards in pepper plantations live anything up to 50 or 60 years. A variety of *E. indica* very similar to the Malabar-South Kanara one is observed to grow in Orissa, West Bengal

A mixed garden of pepper, tea, coconut, arecanut and coffee. Pepper vines are trained on coconut and arecanut trees, as well as on *E. indica* standards

Luxuriant pepper vines trained on coconut trees...

...and on arecanut trees

and Assam and may be of very great use in developing pepper cultivation in these States on a plantation scale.

In household pepper gardens, it is always best to have some vines growing on large trees such as mango, jack, tamarind, hogplum, coconut and arecanut, so that the vines live for decades, even for 100 years and give steady and heavy yields. Such old vines are an asset to the owners and could be depended upon to give a very steady annual income with very little expenditure. The use of comparatively short-lived trees as standards for pepper vines should be resorted to only if extension of a household pepper garden is desired for getting quick returns or if a large-sized pepper plantation is to be raised. Then trees like *Erythrina indica* (Malabar-South Kanara variety preferably), *Garuga pinnata, Oroxylon indicum, Spondias mangifera, Glyricidia maculata* and even the drumstick tree or the most common trees in the particular locality may be chosen as standards.

Garuga pinnata (*thekkan karayan or kilinjil*). This is a popular standard used for pepper in the household gardens in Central and North Travancore as well as in Malabar. Large-sized cuttings, five to six feet long and with a diameter of three inches, which are obtained from large trees, should be used for raising standards, as the seedlings of this plant are slow in growing. These cuttings should be planted immediately after they are removed from the trees and after the receipt of a few very heavy showers in May. Under favourable conditions, a very high percentage of the standards strike roots. Pepper vines trained on *G. pinnata* grow very satisfactorily though not so well as on *E. indica*. *G. pinnata* standards live much longer than those of *E. indica*, stand lopping better and are preferred to the latter in the Central and North Travancore region. The leaves of this tree form a good green manure.

Oroxylon indicum (*azhanthal* or *payyani*). This is also a very good standard for pepper in the household gardens and is popular in the North and Central Travancore region. It is a

Pepper vines grown on *azanthal* standards

quick-growing, soft-wooded tree with an umbrella-like crown of large compound leaves at the top. The tree has to be raised from seed, as cuttings are not very successful. Seedlings are raised carefully from the winged seeds and planted out in their permanent places at least a year or two before pepper vines are planted. The tree grows straight with a few branches and lives on an average for 25 years in household gardens. Pepper vines climb and grow vigorously on this tree and give good yields. The tree is suitable for small scale plantations also. It may not stand very droughty conditions, and has the disadvantages of shedding its leaves in summer and not being very amenable to lopping.

Spondias mangifera (hogplum or *ambayam*). It is another tree suitable as a standard for pepper vine in the homestead gardens. It can be propagated through cuttings. Large-sized cuttings taken from trees may be used for raising standards as in the case of *Garuga pinnata*. Pepper vines

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climb easily, develop well on *S. mangifera* which has a dark green foliage and provides a good shade to the vines. It withstands lopping. Another important point in the favour of this tree is that its tender fruit is used as a vegetable and can be picked.

Glyricidia maculata. This well-known green manure tree can also be used as a standard for pepper vines in homestead gardens. In Malaya, this tree is often used as a live standard for pepper vines, and there is no reason why this could not be done in India too. In this case also, large-sized cuttings should be used for raising standards as its seedlings are very slow in growing.

Glyricidia, as it is commonly known, can stand a severe lopping, and its foliage can be used as green manure for pepper vines as well as for other crops. It is now a common practice all over south India to grow *Glyricidia* along the field bunds and the boundaries of compounds for green manure. These trees can easily be trained in such a way as to serve as standards for pepper vines.

There is a growing tendency in the Travancore region to use this tree as a standard for pepper on the field bunds and boundaries. But the tree is not favoured as a standard in large-sized plantations as its growth does not keep pace with the growth of the vines. In North Travancore, there are a few pepper plantations in which the majority of the standards are of *Glyricidia.*

Other standards. The drumstick tree, which is very often grown in the homestead gardens throughout the West Coast, is also a good standard for pepper. Good, vigorous pepper vines are seen growing on this tree throughout the pepper belt. As is well known, the fruits and leaves of the drumstick tree are used as vegetables.

A number of tea planters in the Travancore region have very successfully grown pepper on *Grevellia,* the tree which provides shade for tea. Pepper vines grow very well and give

good yields on this rough, barked, straight-growing tree. In some tea gardens, *Grevellia* trees are beheaded 20 to 25 feet above the ground level to form an umbrella-like shade; such trees form excellent standards for pepper vines. Pepper vines grown on *Grevellia* give a very good additional income to tea planters with very little additional expenditure.

In the Travancore region, some growers train pepper vines on the rubber trees also, especially in the small rubber plantations. The vines are planted four to five feet away from the rubber tree and are trained on it in such a way that the vines begin to climb the rubber tree four to five feet above the ground level, leaving the lowermost four feet of the trunk free for tapping purposes.

Pepper vines trained on concrete posts

Young pepper vines trained on concrete posts in Kanjirapalli, Kerala. No shade whatever is provided. The vines, though of productive varieties, seem to be shy in bearing

Dead-wood posts are commonly used as standards in Indonesia, Malaya, Indo-China and other regions of the East Indies. Like the teakwood or *belian* (*Eusideroxylon zwageri*) posts about ten feet high. The vines are sometimes trained on to arecanut trees also. These posts rarely last for more than ten to 15 years, which is about the maximum life of the pepper crop in these regions.

In the central Travancore region, a few growers have successfully grown pepper vines on teakwood-post standards in low-lying areas under ideal moisture conditions and under the shade of coconut trees. Due to their high cost, which is nearly ten rupees each, and relatively shorter life, the use of dead-wood standards in India is not a practical proposition.

A few growers in the Travancore region have also tried concrete posts as standards, but these have not been found to be successful. In the open, these concrete posts get heated up and affect the growth of the vines. In the shade, the concrete becomes cool and encourages a vegetative growth. The cost of concrete posts is also high, which is about eight rupees for a single post.

Palm trees in general are found to be excellent standards for pepper vines. The arecanut tree has been commonly used as a standard in homestead gardens from time immemorial. In the North Kanara and Mysore region, the areca tree is used as a standard not only in the household gardens but also in areca plantations where cardamom and banana are grown as other subsidiary crops.

In recent years with the increase in the price of pepper, the popularity of coconut tree as a standard for pepper has vastly increased, and excellent pepper vines on coconut trees can now be seen in homestead gardens in Kerala. Pepper vines also thrive very well on the palmyra palm, the bastard sago palm and the wild date palm.

Of all the palms, the coconut palm seems to be most kind to pepper vines and there seems to be a very good adjustment between them with regard to their demand for nutrition and moisture from the soil. The best development of pepper vines seems to depend on this sort of adjustment of the vine with the standard tree. It is a well-known fact that the

A mixed garden of pepper vines with young coconut and banana trees. *E. indica* is the standard for pepper vines

Pepper vines interplanted among coconut trees, on *E. indica* standards

coconut tree develops normally and gives a satisfactory yield only where soil moisture conditions are favourable, especially in the dry season. Pepper vines can be grown successfully in association with the coconut tree only in those areas where these conditions are fulfilled. There are innumerable homestead and other coconut gardens where these conditions exist and where pepper vines can be grown on coconut trees successfully. Coconut trees provide enough shade required by pepper vines in the hot season, provided the trees are spaced at about 25 feet square or there are 60 to 80 trees per acre. Where pepper vines are interplanted with coconut trees on *E.indica* or other standards at the time of planting the coconut trees, the vines remain productive only during the pre-bearing period of the coconut trees and die out by the time the coconut trees start bearing. However when the coconut tree is used as a standard for pepper vines, the vines develop normally and give good yields.

SHADE REQUIREMENTS

The pepper vine requires little shade except when it is young. Exposure of young vines to the hot sun is found to

be injurious. It is also desirable for the crop to have a little shade during the hottest part of the year. However, too much shade during the flowering and fruiting stages of the vine is found to affect not only the yield but the health of the vines as well, resulting in the reduction of the degree of their bisexuality. Regulation of shade is, therefore, essential and should be attended to regularly. As a rule, the tree used as the standard provides the vine with the necessary shade. During the rainy season the shade should be removed by lopping the standard. The standard should be such that it retains the leaves during the hot weather and puts forth new leaves with the commencement of the monsoon in June. The vines thus get enough shade during the hot months of March, April and May. Lopping, if done immediately after the monsoon sets in, provides sufficient sunlight

A mixed plantation of arecanut, pepper vines, cardamom and banana near Sirsi in North Kanara

for the flowering of the vines and the formation of berries. Lopping of standards, except *murikku* (*E.indica*), is usually undertaken in June to July. *Murikku* is generally lopped in March. It sheds all its leaves and does not provide sufficient shade when pepper vines need it most. It is not lopped during the rainy season as the cut ends are reported to harbour wound parasites which cause rotting of the trees at the top.

It is a common sight to see very thickly-shaded homestead pepper gardens throughout the West Coast. This is mainly due to the lack of regulation of shade through neglect resulting in the weakening and degeneration of pepper vines. In such gardens, the large mango trees and jack trees, which stand close together, should, if possible, be thinned out and also lopped in right time.

In Indonesta, Malaya and Indo-China where dead-wood standards are used, no shade whatever is available for pepper vines. Shade is not needed also in these parts, as the climatic conditions of these equatorial regions with cloudy weather and almost a daily rainfall make it unnecessary.

CULTURAL METHODS

Widely different cultural methods prevail in the different pepper-growing tracts of the West Coast.

In the Malabar and South Kanara region, two diggings and weedings are given to the pepper crop in a year, the first during the South-west monsoon and the second soon after the North-east monsoon. The first digging conserves rain water and minimizes the surface run-off, and the second digging keeps the soil loose and conserves soil moisture. Most of the planters do these operations regularly year after year.

In the Travancore region, digging is done only round about each vine. There is a lot of difference between the Malabar-South Kanara region and the Travancore region regarding soil moisture conditions. The rainfall

A year old pepper vine with its lower portion covered with coconut husks. This will help conserve soil moisture

much more evenly distributed in the Travancore region than in the north. In the Travancore region, the North-east monsoon extends up to the middle of January, whereas in the Malabar-South Kanara region it rarely extends beyond November. The soil moisture problem is, therefore, less acute in the Travancore region than in the Malabar-South Kanara region. During the past years, there were only a few cases of pepper vines drying up in the Travancore region due to drought, while in the Malabar-South Kanara region many vines dried up.

Pepper growers everywhere are of the view that if digging is done in the pepper gardens, it should be done regularly as irregular digging ruins the vines.

In the North Kanara-Mysore region, pepper is grown only as a subsidiary crop in arecanut gardens, the arecanut trees forming the standards for pepper vines. The arecanut

trees are situated in the lower slopes of valleys. As natural drainage is defective in such situations, elaborate arrangements are made for drainage. The area of a garden varies from two to ten acres, a majority of gardens having an area less than five acres. The gardens are clean cultivated. No special cultural operations are undertaken for pepper vines excepting the tying of the vines to the standards.

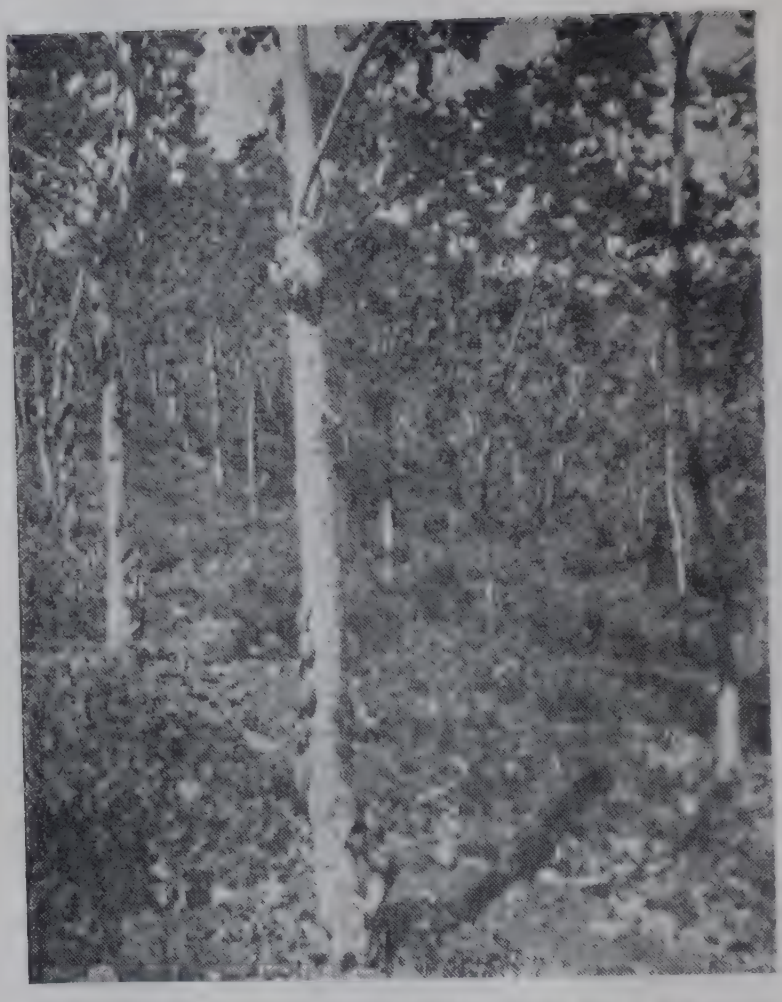
In Coorg, where pepper is trained on shade trees of coffee, it is not possible to correctly estimate the number of vines per acre in a coffee-cum-pepper plantation. It may be anything from ten to 40. Once the vines are established, they do not receive any special attention. However, they receive the benefit of the periodical weeding, manuring and other cultural operations given to the coffee crop. Except on harvesting, little is spent on the maintenance of the vines.

In the Hosdrug sub-taluk, in the southern parts of the South Kanara dtstrict, pepper is grown mostly on large scale plantations, and it is here that the finest and the best organized pepper plantations in India exist. Some of the largest plantations among them have an area of a 100 to 150 acres. These plantations are located on the hill slopes with elevations ranging from 1,000 to 1,500 feet. Two diggings are given annually to these plantations. As these plantations are mostly on fairly steep hill slopes, it is a very good practice among these planters to leave a tuft of forest as a cap on the tops of these hills. This tuft of forest conserves moisture, reduces soil erosion and keeps the lower reaches of the slopes sufficiently moist even during the dry season and thus prevents the complete drying up of these hill slopes during the long spells of drought, which is a characteristic of this region.

The question of preventing soil erosion in the slopy portions of pepper plantations is of very great importance. Many progressive pepper planters of the region undertake contour bunding and terracing. Some growers provide a terrace for each pepper vine. All these operations help prevent soil erosion.

A very good way of laying out a pepper plantation is by undertaking contour terracing

A pepper plantation showing individual terracing for each pepper vine



A young pepper plantation at the Pepper Research Station, Panniyur, grown with a cover crop of *Calopogonium mucunoides.* **(Note how** *calopogonium* **covers the hill slope)**

Experiments on providing a leguminous cover crop for the pepper garden are in progress at the Pepper Research Station, Panniyur. Of all such cover crops, *Calopogonium mucunoides* seems to be the most suitable for pepper gardens. If seeds of *Calopogonium* are broadcast in the garden before the beginning of the monsoon, the plants grow rapidly and cover the entire area with a thick, dark green foliage protecting the surface of the soil during the rainy season by preventing the surface run-off. The roots of this leguminous crop enrich the soil. In summer, the plants die and shed all their leaves, forming a two or three-inch thick

mulch on the soil surface. This prevents the loss of moisture and provides a rich nitrogenous organic manure to the soil. The luxuriant growth of this cover crop smothers all weed growth during the rainy season. Seedlings from self-sown seeds replace the old cover in the succeeding season. The only thing to be guarded against is the smothering of the young pepper vines by the luxuriant growth of *Calopogonium*. Where contour bunding and terracing is done, *Calopogonium* can be grown on the bunds and on the edges of the terraces, to bind them as well as to provide mulch and manure.

To protect the young pepper plants from the heat of the sun during the summer months, a few leafy twigs of any tree which do not easily shed their leaves after drying, are tied over the young plants in March but are removed with the onset of the monsoon. This kind of shading is done for the first two years and after that only those plants which need protection from the sun are shaded. In the third year, in addition to these cultural operations, the side branches of the standards are pruned and trained to grow straight.

Every year the vines should be tied on to their standards with some kind of fibre or even a coir rope to facilitate their climbing. In North Kanara, the leaf sheaths of areca palms are torn into strips and used for the purpose. This operation is carried out regularly either in May, just before the monsoon sets in, or at the end of the monsoon in September. The areca palm does not offer a good hold for the aerial climbing roots of pepper. Therefore, an elaborate system of tying of the growing shoots of pepper is adopted. About 20 strings are used for tying a full-grown vine.

Most of the varieties of pepper of the Travancore region appear to be better climbers than the Malabar varieties, and need tying only for the first three years. In the Malabar and South Kanara region, tying of vines has to be undertaken regularly every year.

MANURING

Until very recently, manuring of pepper vines was not considered important. This was because only virgin forest land rich in humus-content, or land left uncultivated for at least six years and over-grown with scrub jungle was generally chosen for establishing pure pepper plantations. Such rich land did not require manuring to begin with. In mixed household gardens also, the need for manuring does not generally arise as the standard and other trees which are of economic importance are manured, and the pepper vines are also benefited thereby. Experienced pepper growers are of the view that even on a virgin land, a pepper crop begins to decline in productivity in about the 15th year after planting, and to maintain the productivity at a normal level the land should be replenished with humus and soil nutrients utilized by the pepper crop during its early life.

Some growers in the Malabar and South Kanara region used to manure their vines with cattle manure and wood-ash. In the Travancore-Cochin region, it used to be a fairly common practice to apply liquid cattle manure or cattle manure and wood-ash to pepper vines two or three times a year, particularly to the vines planted to large trees in household gardens. In the North Kanara and Mysore region, where pepper vines are trained on to areca palms, the palms are given a heavy application of green-leaf mulch to a depth of two to three feet and one basket of cattle manure alternately, every year. The pepper vines receive the benefit of the attention bestowed on the areca palms.

Experiments conducted at the Agricultural Research Station, Taliparamba, Kerala, showed that pepper vines responded favourably to the application of fish manure at the rate of a quarter pound per vine, recording about a 75 per cent increase in the yield over the unmanured vines. Another trial carried out at the same Station from 1929 to 1939 showed that the application of slaked lime at the rate of half a pound

per vine in alternate years increased the yield of the vines by about 100 per cent. The most favourable response was when nitrogenous and phosphatic fertilizers were applied in conjunction with slaked lime. Manurial experiments conducted at the Agricultural Farm, Konni, Kerala, have shown that application of three ounces of ammonium sulphate and ten ounces of superphosphate per vine increased the yield by about 33 per cent. However, continuous heavy applications of nitrogenous manures for forcing the vines to yield more, according to some scientists, is likely to cause sudden death or wilting of the vines.

The average yield of a pepper vine in mixed gardens on the West Coast of India is roughly a pound of black pepper per year. In well-organized and well cared for pepper plantations in South Kanara and North Malabar, the average yield of a vine is anything up to one and a half pounds. In Sarawak, Indonesia and Indo-China, the yield per vine is five to six pounds. In order to make pepper cultivation sufficiently attractive, the yield of pepper vines in India has to be substantially stepped up by a balanced and judicious manuring.

Well-planned experiments on the manuring of pepper vines have been laid out at the Pepper Research Station, Panniyur, the results of which are awaited. In the meantime, the following tentative recommendations on manuring pepper vines are given.

(1) Well - rotted cattle manure or compost	Ten pounds per vine (just before the South-west monsoon)
(2) Ammonium sulphate	One-eighth pound along with the cattle manure
(3) Groundnut cake or castor cake	Half a pound per vine in two doses (just before the two monsoons)
(4) Superphosphate or bone-meal	One-fourth pound per vine (just before the North-east monsoon)
(5) Sulphate or muriate of potash	One-fourth pound per vine (after the South-west monsoon)
(6) Slaked lime	One-fourth pound per vine in alternate years

Excepting slaked lime, the manures and fertilizers should be applied about a foot away from the stem of the vine, all-round within a radius of two to five feet, nearer for the young and farther for the old vines. Ammonium sulphate and potash should be applied as a top-dressing and the other manures incorporated into the soil to a depth of about six inches. Slacked lime may be applied closer to the vines, and should be well incorporated into the soil.

HARVESTING AND PROCESSING

Pepper vines commence yielding usually from the third year, the yield increasing gradually until the vines come to full bearing in about ten years. The economic life of a vine varies from place to place. From the tenth to the 25th year,

the vines are in full bearing. In most areas, the yield begins to decline rapidly after the 30th year. This is the case with the pure plantations of pepper. In the household gardens, pepper vines trained on large trees can be very productive for anything up to 100 or more years. In the regions, where pepper forms an intercrop in coconut plantations, the vines do not live for more than 12 to 15 years due to the preponderant growth of the coconut trees.

On the West Coast, the vines usually flower in June and July after the commencement of the South-west monsoon. Flowering is sometimes initiated by heavy pre-monsoon showers in April or May. The harvesting season of pepper on the West Coast extends from the middle of December to the middle of March. In the coastal areas, which are almost at the sea level, harvesting is done early, from December to the end of January. On the foothills and on the Western Ghats upto elevations of 3,500 feet, the harvest of pepper extends from early February to the middle of March. The lower the temperature and the higher the elevation the later is the harvest. In the Travancore-Cochin region, rainfall is fairly evenly distributed, unlike the seasonal rainfall and long spells of dry weather in the Malabar and South Kanara region. Heavy and evenly-distributed summer showers are received in the Travancore-Cochin region even in April and May. This usually induces pepper vines to flower, and the crop can be harvested in December and January. As one goes further north, the flowering is delayed until February to March.

These facts indicate a great influence of elevation, temperature, distribution of rainfall and other climatic factors on the flowering and fruiting of pepper vines. The yield of pepper fluctuates widely, depending mainly on the seasonal conditions. Pepper vines are observed to be very sensitive to small changes in the weather conditions at the time of flowering, fruit-setting and fruit development. Timely rainfall is an all-important factor affecting the yield.

It is estimated that the average yield of a pepper vine on the West Coast is a pound of dried black pepper. Yields up to 51 pounds of dry pepper per vine have been recorded, but such vines are rare and met with only on large trees. In pure plantations, in the Malabar and South Kanara region, a yield of 400 to 500 pounds of dry black pepper per acre (330 vines) is considered normal.

Harvesting pepper

As flowering of a pepper vine usually takes place in one flush, the harvesting of berries is also done at one time. When a few of the berries on a vine are seen to have ripened, turning red or orange in colour, the entire crop of the spikes of the vine may be harvested. Sometimes a vine may produce two or more flushes of flowers successively; in such cases two or more harvestings have to be done as the flushes ripen.

Harvesting is done with the aid of a ladder leaned against the standard. A man climbs up the ladder, pinches off entire spikes and puts them in a bag hung on his back.

The preparation of commercial black pepper from the harvested spikes is simple. The whole spikes with the berries are spread on a mat or a clean floor and rubbed between the hands or trampled under the feet to separate the berries. The berries are then fully dried in the bright sun for four to five days or even more. When fully dry, the outer skin of the berries becomes black in colour and gets shrunken, and the berries get the characteristic wrinkled appearance of the black pepper of commerce. The complete drying and moisture-proof storing of black pepper are very important in preventing insect and fungus attacks in storage.

The percentage of dry black pepper obtained from green pepper varies from variety to variety, from about 26 to 39 per cent. Some of the productive, high-yielding varieties such as *Kalluvally, Uthirankotta, Kothanadan, Karimunda* and *Kaniakadan* produce very heavy black pepper—about 34 to 39 per cent of green pepper.

White pepper is prepared by removing the outer skin of the green pepper berries by soaking them in water immediately after harvest and trampling them under the feet for removing the outer skin. At present, white pepper is not of any commercial importance.

The dry, black pepper is thoroughly cleaned, and all undersized and unripe berries and dirt are removed to make it fit for the market.

Some producers as well as merchants sort out black pepper into different grades for its uniformity and easy sale at higher prices.

ECONOMICS OF PEPPER CULTIVATION

THE fact that pepper is essentially a homestead garden crop is of fundamental importance in discussing the economics of its cultivation. More than 80 per cent of pepper produced in India comes from the homestead gardens. The pepper produced in the Travancore-Cochin region, which is more than 50 per cent of India's pepper production, comes almost entirely from the homestead gardens. Of the 2,12,000 acres under pepper in India, only about 15,000 to 20,000 acres are under pure pepper plantations.

In the homestead gardens, very little is spent on the maintenance of pepper vines. The diggings and manurings given to the trees and other crops in such gardens benefit pepper vines also. If at all any attention is bestowed on pepper vines in such gardens, it is done mostly by the members of the household. Under these circumstances whatever return is obtained from pepper vines in a homestead garden is gain for its owner.

The consideration of the economics of pepper cultivation arises only when pepper is grown on fairly large-sized plantations.

The initial cost of laying out a pepper garden is rather heavy in the Malabar-South Kanara region. The area to be planted has to be cleared of all scrub trees, weeds and old stumps. Pits at the rate of 1,000 per three acres have to be dug and standard trees planted before the planting of pepper vines. Pepper is a crop which requires continuous attention and care. A pepper garden needs regular cultivation to keep the land free from the weed and jungle growth. Negligence in this respect not only reduces the yield but also

permanently ruins the plantations. Therefore, whether a good crop and price are realized or not, one cannot afford to neglect his pepper plantation. With the slump in the price of pepper during years 1931-1941, a large proportion of pepper plantations on the West Coast became derelict and were abandoned as the prices obtained were far below the expenses. Of course, the extraordinary high prices obtained for pepper in the near past bear no relation whatsoever to the cost of production.

The cost of cultivation of three acres of pepper (1,000 vines), in the Malabar-South Kanara region on a plantation scale at present is as indicated below.

FIRST YEAR

	Rs.
Burning and clearing the scrub	100
Cleaning and digging pits	50
Training and planting standards (60 men)	90
Wages for coiling and cutting vines and planting (20 men)	30
First digging (120 men)	180
Second digging (40 men)	60
Tying vines (15 men)	25
Mulching (30 men)	45
Total	580

SECOND YEAR

	Rs.
Cleaning the scrub (20 men)	30
Cleaning and digging (120 men)	180
Tying vines (20 men)	30
Terracing (100 men)	150
Total	390

THIRD YEAR

	Rs.
Cleaning the scrub (20 men)	30
Cleaning and digging (120 men)	180
Tying vines (20 men)	30
Lopping of standards including collecting trippings (50 men)	75
Total	315

FOURTH AND FIFTH YEARS

	Rs.
Fourth year	315
Fifth year	315
Total for the first five years	1915

The cost of manuring, raising nurseries of rooted cuttings, prevention of pests and diseases, and harvesting has not been included in the cost of cultivation calculated above. As pepper vines start yielding only from the third year and come into full bearing only in about the tenth year, the initial expenses of laying out a pepper plantation can be recovered only after several years, and this depends on the price level of pepper.

The best organized and most extensive pepper plantations of India are in the Hosdrug sub-taluk of South Kanara district and in North Malabar. One of the most prominent among the pepper planters of this region is of the view that unless the price of a kandy (700 pounds) of pepper remains at a high level of anything between Rs. 1,500 and Rs. 2,000, it would be impracticable and unprofitable to maintain large scale planations of pepper in these regions. If prices go down far below this level, large-scale pepper plantations may have even to be abandoned. The cost of the cultivation of pepper can be brought down only if the general price level is brought down substantially. There does not seem to be much hope for this in the near future.

The pepper vine is a very delicate plant and needs a constant attention and an intensive care. It is impossible to keep a large plantation in good tip-top condition, without incurring very heavy expenditure and without great efforts. Under the existing conditions, no one planter should have more than about ten acres of pepper crop. As envisaged now, one of the ways of stepping up the production of pepper in India is to extend its cultivation to all suitable areas by establishing pepper plantations and homestead gardens.

DISEASES AND PESTS OF PEPPER

THERE are two serious diseases of pepper met with in India; one is wilt and the other *pōllu*.

Wilt. In the year 1902, the attention of the Madras Agricultural Department was drawn to the prevalence of a disease which was causing a considerable damage to the pepper crop in South Wyanaad (Malabar). The disease was in fact wilt causing the death of the vines. A careful inspection showed that in these areas the practice of heaping up soil to form a mound around the base of the vines was prevalent. This induced the formation of superficial fibrous roots, in addition to the normal root system, which permeated the soil in the mound. It was observed that in all the diseased vines, the surface roots were the first to rot and perish, while they remained healthy in the normal vines. It was also observed that vines in exposed situations succumbed more readily to the disease than those under shade. An attack from a fungus was found to be the cause of this disease.

Root rot, resulting in wilt, is met with, to a small extent, in all pepper-growing tracts, involving two to ten per cent of the vines. In certain years, a much higher percentage of death occur. An examination of the wilting vines showed that different kinds of fungi could have caused the disease.

Wilt is observed to be a major problem in the hill regions away from the coast. In localities nearer to the coast only stray vines are killed by wilt. The disease is prevalent throughout the pepper belt of the Travancore-Cochin region and the Malabar-South Kanara region. A critical survey of the wilt-affected areas showed that the incidence of wilt was caused by any one or more of the following factors.

(1) A low soil depth and the presence of a large amount of disintegrating granite rock

(2) A poor soil fertility with a very little humus-content

(3) A severe soil erosion resulting in the exposure of the base and roots of the vines

(4) Neglect of the plantation

(5) A severe exposure to the afternoon sun, particularly in the summer

(6) Poor drainage and water stagnation

In localities nearer to the coast, wilt has been found to be closely associated with disintegrating granite rock, poor soil depth, severe exposure to the afternoon sun and poor drainage of the soil.

Investigations on the methods of controlling this disease are in progress. The chief symptoms are the yellowing and shedding of the leaves, followed by the death of the vine. The only way now known of controlling the disease is to carefully remove all the dead plants—roots and all—and burn them. The affected plants may be saved by the application of three or four pounds of slaked lime soon after the beginning of the monsoon. Lime should be applied by broadcasting it on the surface of the area covered by the root sysem, and inculcating it into the soil. This treatment may arrest the course of the disease and revive the vines. If lime is applied in the dry season, the vines should be profusely watered for a few days after its application. Even mere watering the affected plants in the dry season may revive the vines. The affected plot should be kept well drained and clean.

Attempts are being made at the Pepper Research Station, Panniyur, to select the naturally wilt-resistant vines. Among the various varieties of pepper, *Uthirankotta* and *Kalluvally* of the Malabar region and *Cheriakaniakadan* of the Travancore-Cochin region, as well as some wild varieties, are observed to be comparatively resistant to wilt.

As indicated previously, the possibilities of preventing the wilt disease by using the wilt-resistant root-stocks for pepper are also under investigation at the Pepper Research Station, Panniyur. Susceptible varieties are being grafted on to resistant root-stocks of *Uthirankotta* and *Piper attenuatum* (wild) for trials in the wilt-infested fields.

The first generation hybrids between the resistant and susceptible varieties are also being tested similarly for resistance to the disease, and there are indications that wilt-resistant hybrids may be evolved by this method.

Pollu. Another serious disease of pepper prevalent on the West Coast of India is *pollu,* which causes not only hollowness in berries but also a complete destruction to them.

There are two causes of *pollu* : (i) attack by flea beetle and (ii) attack by fungus.

Pollu caused by insect. The chief insect which causes *pollu* is the flea beetle (*Longitarsus nigripennis*), which makes small, hollow, circular holes in the rind of the berries, lays eggs inside, and then covers the eggs with its excreta. The eggs hatch in about five to eight days. The grubs burrow into the kernel and destroy the contents, sometimes right up to the epicarp, leaving only a light hollow shell. The insect later enters the neighbouring berries which are similarly hollowed out. The berries turn black and do not ripen, although they remain attached to he spikes. The loss from *pollu* may range from six to 21 per cent.

An examination of a number of the *pollu*-affected berries in the Travancore region revealed the presence of the maggot of a *Cecidomyidae* fly inside. Therefore, one of the agents for causing *pollu* may be the maggot of this fly.

The *pollu* caused by insects is generally indistinguishable from the *pollu* caused by fungus.

Pollu caused by fungus. A fungus (*Collectotrichum*) has been found responsible for causing the shrinking and drying

up of individual berries and for attacking the stalk of the spikes. The fungus causes circular or irregular grey spots on the leaves. It also sometimes attacks the stem from the tip, descends to a limited extent and gradually kills it. The attack on the spikes and berries is more serious and results in the loss of the crop. Evidently the infection begins with the leaf and the stem. The tender, fallen spikes show a fungus attack. The spikes are generally attacked at their attachment to the stem, causing them to fall. Vines in shady and damp plots are affected more than those in open places. Berries from the fallen spikes become hollow and light when dried. The disease also attacks individual berries on a spike. The extent of the loss of the crop due to this type of *Pollu* is anything up to 30 per cent.

Pollu is found throughout the pepper-growing belt of the West Coast, but its incidence varies from place to place. In the Travancore-Cochin region, the incidence of *pollu* is not of much consequence as it is in the Malabar region.

The incidence of *pollu* is found to be more or less directly proportional to the density of shade. There is no marked difference among pepper varieties regarding the incidence of *pollu*.

Trials have shown that spraying the vines with Bordeaux mixture, soon after the berries have set, is effective, to a certain extent, in controlling this disease.

Pests. Besides the flea bettle there are a few other insect pests which damage the pepper crop. They are the gall fly, the scale insects, the mealy bug and the stem borer.

The gall fly, *Cecidomyidae*, also does the same damage as the flea beetle and causes swellings on tender leaves, leaf stalk and stem.

Pepper scales are small, grey insects having boat-shaped scales. They are an exclusive pest of pepper. They attack

the main stem and the leaves of the vines; the badly-infected vines may even dry up. There is also a scale insect which is very convex and spherical in shape and has chocolate-brown colour. This is found attacking the stem, spikes and berries of pepper in Coorg.

Mealy bugs are also found attacking the vegetative parts of the pepper vine. The vines sprayed with resin-Bordeaux mixture at the Agricultural Research Station, Taliparamba, were found attacked during the subsequent summer by these mealy bugs. This was one of the reasons why the spraying of Bordeaux mixture against *pollu* had to be discontinued, although the spraying reduced the incidence of *pollu*.

The stems of pepper vine were found attacked by a stem borer in the Cochin region and Coorg. The attacked vines wilted and dried up.

Pests of stored pepper.. Black pepper is generally immune to the attack of insects. But it has been found that the presence of moisture induces mould-formation which results in insect infestation. The types of such insects identified are (1) the book-lice or *psocids*, (2) cereal mites, (3) grain beetles, (4) cigarette beetles and (5) drug-store beetles. The best method of control of mould-formation and insect infestation in stored pepper is to reduce the moisture content by proper drying and moisture-proff storing. A ten per cent moisture content is considered the marginal limit in this respect.

Sitodrepa panicea, the drug-store beetle, is a serious storage pest of dry pepper all over the West Coast. It is more common in pepper stored for more than a year. Storing pepper for long periods in the same room or receptacle year after year without any cleaning, and storing it along with other spices like ginger and turmeric cause the insect attack. Fumigation of dry pepper with 'Chlorosol' has been found to be effective in controlling this serious pest. Fumigation of pepper with stockists and merchants, therefore, is

necessary to control the pest. Although the stock available with exporters indicates very stray incidence of the pest, most of the insects get eliminated during the process of garbling, etc. However, it is desirable to fumigate these stocks immediately before export to eliminate even the slightest chance of infestation by this insect.

To eliminate the possibility of pepper getting mouldy, treating dry pepper with 'corvus oil' is fairly effective. It has also been found by experimentation that the provision of an alkathene film inside the gunnies used as containers for pepper is the most effective measure to prevent moulding.

USES OF PEPPER

PEPPER is commonly used as a spice in flavouring food stuffs. It is also used for curing and preserving meat.

An oleo-resin is extracted from pepper by putting powdered pepper in alcohol and keeping it for some days till all the soluble matter is dissolved in alcohol. The insoluble matter is separated from the alcohol and the oleo-resin extracted by evaporating the alcohol. Traces of this, applied to food-stuffs, give the necessary pungency and flavour of pepper.

Piperine, an alkaloid, is extracted by suitable chemical processes and is used medicinally as a carminative and as a febrifuge and antiperiodic in malaria. From piperine, pipperic acid and piperidine are synthesised. An insecticide against houseflies can also be prepared from piperine.

The essential oils of pepper have only the smell of pepper without the pungent taste. According to E. J. Perry, oil is extracted by distilling the unripe berries of pepper which have an oil-content of about one to two and a half per cent. A firm in Kozhikode has extracted the oil by distilling powdered pepper with steam under pressure. The colour of the oil is yellowish. The pepper powder after extracting the oil can still be used for all ordinary culinary purposes. It can also be used for extracting the resin with alcohol.

According to Brury, pepper contains an acrid soft resin, volatile oil, piperine (five to 8.55 per cent), gum, bassorine, malic and tartaric acid, the odour being probably due to the volatile oil, and the pungent taste due to the resin. The berries are used medicinally as a stimulant and stomachic and, when roasted, have been employed successfully in stopping

vomitting in cholera. The root is used as a tonic, stimula and cordial. A liniment is also prepared from them for u in chronic rheumatism. The watery infusion of pepper h been used as a gargle in relaxation of uvula. As a season of food, pepper is well known for its excellent stomachic qu lities. An infusion of the seed is given as an antidote arsenic, and the juice of the leaves boiled in oil is appli externally in scabies. Pepper in over-doses acts as poiso by overexerting the inflamation of the stomach and acti powerfully on the nervous system. It is known to be a pois to hogs. The distilled oil has very little acrimony. A ti ture made in rectified spirit is extremely hot and fie Pepper has been successfully used in vertigo and in paraly and arthritic disorders.

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